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DEVELOPMENT OF A FATE/TOXICITY SCREENING TEST

by

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Cooperative Agreement CR809797-01

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Half-life values for the 10 chemicals evaluated varied substantially with time and geographic sampling site. In active systems, 8 of the 10 chemicals degraded more rapidly than methyl parathion. Nine dibutylphthalate screens were run involving six geographic sites. Disappearance was quite rapid in active treatments in all screens. Disappearance curves describing DBP abatement either: (1) appeared to be substrate dependent with the rate of degradation decreasing as DBP was depleted; (2) appeared independent of substrate concentration; or (3) reflected a marked increase in degradation rate during the screening period.

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ABSTRACT

A shake-flask screening test was designed to rapidly evaluate the relative degradation rates of a wide spectrum of chemicals, each compared to methyl parathion. Test chemicals evaluated were bolero, bravo, dibutylphtha'ate, dimilin, dursban, endosulfan, hoelon, pentachlorobenzene, phorate, and trifluralin. Diverse regimes of salinity, pH, TOC, and microbial biomass were encountered across space and time. The experimental design for the screening test embodies four treatments: active sediment, sterile sediment, active water, and sterile water. Decay curves were produced and rate constants and half-life values determined.

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SECTION I

INTRODUCTION

Since passage of the toxic substance control act in 1974, there has existed an increasing need for a rapid but informative screening test by which to evaluate the potential environmental hazard of the variety of chemicals produced and submitted for registration in this country each year. A screening test of this nature should: (1) be relatively rapid; (2) not require the use of radiolabelled materials; and (3) detect the presence of toxic degradation products should they be produced. These criteria are essential in enabling industry as well as private laboratories, the probable ultimate users, to utilize the screening test on an infrequent basis without prohibitive physical or economic restraints. The requirements of the test also prescribe that the resultant data be sufficient to enable user and regulatory agency alike to determine the environmental hazard (or lack thereof) of the compound in question and whether or not additional, more sophisticated, testing is in order.

The resultant screening test is a shake-flask incubation similar to the standard river dieaway test. It differs from the river dieaway test in two important aspects: (1) it takes into account the effect of sediment on the degradation of the test compound; and (2) it includes a mechanism by which toxicity not necessarily associated with the parent compound can be ascertained. The test was developed jointly by the Gulf Coast Research Laboratory, Ocean Springs, Mississippi, (GCRL), and U.S. EPA Environmental Research Laboratory, Gulf Breeze, Florida (ERL-GB) under Cooperative Agreement CR 809797-01. The test is designed to rapidly evaluate a wide spectrum of chemicals, each of which is compared to methyl parathion, a relatively innocuous organophosphate insecticide screened concomitantly with each test chemical. Nomenclature, action, and structure of test chemicals are listed in Table 1.

SECTION II

METHODS

Fate Screen

The experimental design for each test compound embodies four treatments: active sediment, sterile sediment, active water, and sterile water. The active sediment treatment is natural water amended with 500 mg/ℓ underlying sediment. Data provided by this treatment describe the effect of the biological component of sediment on abiotic and biodegradation rates, as well as the effect of this component on the partitioning of the test material between the sediment and water phases of the system. The sterile sediment treatment is sediment-amended water sterilized with two percent formalin. Information derived from this system pertains to the effect of sediment on adsorption rate and equilibrium partition coefficient as well as the effects of solids on the rate of abiotic degradation. The active water system is simply untreated water and provides information regarding degradation, both biological and abiotic, in an essentially aquatic system. The sterile water treatment is formalin-sterilized water and describes purely abiotic degradation mechanisms.

Sediment and Water Collection and Handling. With the exception of dimilin and dibutylphthalate screens, sediment and water were collected from Davis Bayou, an estaurine salt marsh adjacent to the Gulf Coast Research Laboratory. In the dimilin screen, two additional Mississippi sites were utilized, and the dibutylphthalate screens involved a total of six sites from Florida, Mississippi, and Louisiana. Water was collected from approximately 60 mm subsurface by submerging pyrex carboys and filtered either through glass wool or to three microns (Micro Filtration Systems filter no. A300A142C). The upper 5-10 mm of underlying sediment were collected by skimming with a pyrex beaker or with a box sampler (Wildlife Supply Co., Model 196HC) as appropriate and sieved to two mm using a stainless steel sieve. Processed sediment and water were then combined (1:1 v:v) to form a slurry which was mixed, along with the remaining water, by aeration for 24 hours prior to initiating a screen. Sediment concentration in the slurry was determined gravimetrically. Salinity and pH of the water were determined at time of collection.

Addition of Test Compounds. Each test material was added in acetone solution at a concentration predetermined sufficient to produce a final water concentration of 200 µg/ℓ (500 µg/ℓ for dibutylphthalate) to an empty, chemically clean, 19-liter pyrex mixing vessel and the acetone removed by flushing with air. Site water (12-15 ℓ) was added and vigorously stirred, and periodic samples were collected and analyzed for

test compound. When the concentration of test material reached the desired level, the entire contents of the mixing vessel were transferred to a second carboy to halt uptake. Compound-laden water was then transferred in 1.5ℓ aliquots to two-liter erlenmeyer flasks. Appropriate flasks had been previously amended with: (1) sufficient sediment/water slurry to provide 500 mg/ℓ dry weight sediment (Active Sediment); (2) slurry and 20 ml/ℓ 37% formalin (Sterile Sediment); (3) nothing (Active Water); or (4) formalin only (Sterile Sediment). All flasks were placed in controlled environment incubator shakers (New Brunswick Scientific, Edison, NJ) and incubated in the dark at 25 C and 140-150 rpm. Salinity, with few exceptions, was not altered from that of the site water at the time of sampling, and pH was maintained at ambient ±0.2 unit by daily (or every other day) adjustment. Duplicate samples were periodically removed and analyzed for residual test material. Control sediment and water (no test materials or formalin added) systems were maintained for determination of extraction efficiency and for use in respike evaluations (dibutylphthalate).

Chemical Analysis. With dimilin as an exception, residual test materials were quantitated by 1:1 v:v liquid:liquid extraction with 10 ml pesticidequality hexane and gas-chromatographic analysis. Instruments utilized in these evaluations were Tracor 222 chromatographs equipped with Ni^{63} electron-capture detectors. Chromosorb W, HP, 100/120 mesh glass columns packed with OV-1, OV-17 + QF-1, and OV-101 liquid phases as appropriate were utilized. Nitrogen served as carrier gas. All calculations were accomplished using Columbia Scientific Instruments Supergrator-3A programmable integrators.

The low solubility of dimilin in water reduced the maximum attainable concentration to approximately 40 µg/ℓ. Dimilin was added carrier-free as previously described and thoroughly mixed. Contents of the mixing vessel were filtered through prewashed (acetonitrile and 2X distilled water) Whatman 42 paper, transferred to two-liter flasks, and treated as appropriate to produce AS, AW, SS, and SW treatments. Ten-ml samples were periodically taken, filtered to 0.45 µ (Waters Associates sample clarification kits with aqueous filters and prefilters) and analyzed directly by liquid chromatographic techniques. A Waters chromatograph, equipped with a U6K injector, 6000 A pumping system, Model 440 UV detector, and 3.9 mm x 30 cm µBondapak C_{18} 10 µ column, was employed for all dimilin analyses.

Determination of Rate Constants and Half-Life Values. First-order (K_1) rate constants were determined by linear regression according to the relationship: $\ln C = a + K_1 x$, where C = µg test material/ℓ, a = Y-axis intercept, K_1 = slope, and x = time. Half-life values for each test compound were then determined: $T_{\frac{1}{2}} = 0.693/K_1$.

Toxicity Testing

Mysid Shrimp. The mysid shrimp, *Mysidopsis bahia* Molenock, was selected as test species for toxicity evaluations in brackish or salt-water enviroments. *M. bahia* can be readily collected from shallow

salt water ponds receiving direct influx of seawater or from open-sea shallow grass beds. Original stocks utilized in these investigations, however, were provided by Dr. Delwayne Nimmo, U.S. Environmental Protection Agency, Gulf Breeze, FL.

Brood stocks of *M. Bahia* were maintained at GCRL in glass aquaria in aged natural seawater at 26 g/ℓ salinity. Maintenance conditions were static with constant aeration and constant low-level illumination. Temperature was 22 ± 2 C. Accumulated tank debris was removed by siphoning at least weekly, and partial water changes were affected every 2-3 weeks.

Young animals suitable for testing were secured by maintaining adult breeder mysids at the desired test salinity for 7-10 days. Well-advanced ovigerous females were transferred to mesh-bottomed brood chambers designed to preclude egress of adults while allowing facile passage of young. After two days, brood chambers were removed and the young transferred to white sorting trays. Individual young to be tested were then hand-selected using bulbed wide-bore pipettes.

At the inception of each fate/toxicity screen, preliminary, wide-interval range tests were conducted to determine the effect of the toxicant in question on *M. Bahia*. No attempt was made to compute the TLM or related statistic, only to ascertain the approximate minimum concentration required to produce mortality. At various times during each fate screen, generally at time zero and at each half-life thereafter, approximately 500 ml of the active sediment treatment was collected, the sediment removed by centrifugation, and the supernatant analyzed for residual test material. Fifty percent serial dilutions of the supernatant were then prepared, with the middle dilution approximating the minimum concentration shown to be lethal in the range-test. Diluent water in these evaluations was natural high-salinity seawater or Instant Ocean® diluted to the appropriate salinity with distilled water. Test vessels were 100 ml glass beakers containing 50 ml test solution. Five 2-day-old mysids were simultaneously exposed in a minimum of four replications at each treatment concentration. Appropriate diluent water controls were included, and total exposure time was 96 hours with observations at 24-hour intervals. All tests were conducted under static conditions at 22 ± 2 C under continuous low-level illumination. During testing, mysids were minimally fed *Artemia* nauplii.

Water Flea. The water flea, *Daphnia magna* Straus 1820, was utilized as test species for freshwater toxicity tests. Daphniids are generally acceptable as a freshwater test species and reflect relatively high sensitivity to a variety of xenobiotics. Our original *Daphnia magna* stocks were obtained from Ward's Natural Science Establishment, Inc., Rochester, NY. Upon receipt at GCRL daphniids were placed in all-glass aquaria, 70 x 50 x 23 cm I.D., containing four liters of mixed algal cultures. Aquarium size and medium volume is important in that aeration of daphniid cultures is undesirable and may result in lethality due to entrapment of air bubbles within the carapace or upon the abundant setation of the organism causing loss of equilibrium and coordinate movement.

Cultures of *D. magna* were maintained under low illumination (25-50 foot candles), and fed a mixture of unicellular algal species. *Chlorella*, *Ankistrodesmus*, and *Scenedesmus* species, from Carolina Biological Supply Co., Burlington, NC were routinely maintained in our laboratory on Bold's Basal Medium (Nichols and Bold, 1965) fortified with 1.0 µg/ℓ vitamin B_{12}, 1.0 µg/ℓ biotin, and 400 µg/ℓ thiamine under strong illumination. Algal cultures were utilized, either alternatively or mixed, to feed daphniid cultures. Feeding was done in a manner such that essentially all added food would be utilized in 48 hours.

To obtain 1- to 2-day-old daphniids for testing, single, robust, ovigerous individuals were transferred by bulbed, wide-bore pipet to beakers. After 48 hours, the adults were removed, leaving a brood of 24- to 48-hour-old first instar young. Range tests and dilution schemes employed in the daphniid tests were identical to those described for *M. Bahia*. During testing, daphniids were fed powdered dehydrated alfalfa and Ralston-Purina No. 2 Trout Chow.

SECTION III

RESULTS AND DISCUSSION

Fate Screen

Half-life values for bravo, hoelon, PCNB, phorate, trifluralin, dimilin, dursban, endosulfan, and bolero are shown in Figure 1. Regression equations, coefficients of determination, and K_1 values for these screens, repetitive evaluations, and dibutylphthalate screens are listed in Table A-1. Dibutylphthalate and methyl parathion screens will be subsequently discussed. In active systems, half-lives varied from several hours (hoelon) to one month (dimilin). For three of the nine compounds (bravo, hoelon, bolero), half-life in the active sediment treatment was less than 50 percent of that in the sterile sediment counterpart, indicating involvement of the sediment/water microflora in the degradation process. With endosulfan and dimilin, degradation proceeded more rapidly in sterile than in active systems. Two endosulfan screens (October and November, 1981; Table A-1), each consisting of duplicate flasks for the four treatments, were run. The first screen employed formalin as sterilizing agent while in the second 50 mg/ℓ mercuric chloride was used. Results were identical across all replicates in both screens. For dimilin, disappearance of parent compound from aseptic systems exceeded the active systems only in the screen involving Horn Island, MS. This site, a barrier island of the State of Mississippi, is typically high in salinity, near that of the open Gulf, although on this particular date the salinity was 16 g/ℓ. Two freshwater dimilin screens (Table A-1) produced active sediment half-lives of 2.9 and 2.0 days as compared to sterile sediment values of 13.2 and 16.7 days.

Regression equations, coefficients of determination, first-order rate constants, and half-life values for 16 methyl parathion screens are listed in Table A-2. In the active sediment treatment, methyl parathion half-life ranged from 0.9 to 29.9 days with a mean of 12.6 days and a standard deviation of 6.5. In sterile sediment, half-lives ranged from 2.7 to 87.8 days with a mean of 47.9 days and a standard deviation of 25.5 In active water, the range was 1.1 to 56.3 days, the mean 31.1 days, and the standard deviation 14.6. In the sterile water treatment, half-lives ranged from 2.7 to 108.6 days with a mean of 44.3 days and a standard deviation of 29.9. Methyl parathion was screened concomitantly with each test material listed in Table A-1 to compare the degradation rate of each test compound to that for methyl parathion, a thoroughly researched, relatively non-persistent material. These comparisons, in terms of K_1 ratios (K_1 test compound/K_1 methyl parathion) are listed in Table 2. K_1 ratios less than unity indicate test material

degradation rates less than those observed in the accompanying methyl parathion screen. In active systems bravo, DBP, dimilin, endosulfan, hoelon, PCNB, phorate, and trifluralin reflected K_1 ratios greater than one, indicating a more rapid degradation rate than observed for methyl parathion. Dursban abatement was slightly less than that for methyl parathion in active sediment and slightly greater than that for methyl parathion in active water. Bolero disappearance was somewhat inconsistent but appeared to degrade at a rate roughly equal to or slightly slower than methyl parathion. In sterile systems all test materials except bolero and DBP degraded more rapidly than did methyl parathion. Bolero degradation was somewhat reduced as compared to methyl parathion. DBP ratios in sterile systems were erratic due to difficulties in explaining DBP behavior by linear regression. These difficulties are discussed later in this report. The idea of "standardizing" or "normalizing" degradation rates using a benchmark chemical has been proposed by others and, at the screening level, may well represent a valid method of describing the behavior of a relatively unknown xenobiotic.

Dibutylphthalate Screens. Considerable time during this project was spent evaluating the behavior of dibutylphthalate at different geographical sites under conditions of the fate screen. Water and sediment were collected from six sites in Louisiana, Mississippi, and Florida, as illustrated in Figure 2. Site 1 is the Tickfaw River near Springfield, LA, a cypress-marsh freshwater tributary which communicates through Lake Maurepas, South Pass, Lake Ponchartrain, the Rigolets, and Lake Borgne with the Mississippi Sound and hence the Gulf of Mexico. Sites 2 and 3 are located in the upper reaches of the Tchoutacabouffa River and Fort Bayou, respectively. These are typically freshwater areas characterized by pine forests, although both are subject to limited periods of low salinity during times of low rainfall and high tides. These sites furnish fresh water to the Biloxi Bay estuary system which empties directly into the Mississippi Sound. Site 4 is previously mentioned Davis Bayou, a *Spartina/Juncus* marsh adjacent to the Gulf Coast Research Laboratory. Salinity at this site ranges from zero to 25 g/ℓ annually. Site 5 is located on Horn Island, a barrier island some eight miles south of the Mississippi mainland and is typically characterized by salinities in the 20-25 g/ℓ range. Site 6 is Range Point on Santa Rose Island, Florida, an area similar in vegetation and climate to that of Horn Island. Collection and processing of water and sediment and preparation of active and sterile sediment and water treatments were as previously described.

Dibutylphthalate disappearance during nine screening evaluations from the six sites is shown in Figure 3. Disappearance was quite rapid in active sediment and water treatments from all sites. In AS treatments, the time required for residual DBP to fall below detection limit ranged from 2 to 13 days. In AW, this range was from 2 to 17 days. In all sites, degradation in AS systems was equal to or greater than that observed in the active water-only counterparts, emphasizing the involvement of the sediment microflora in the degradative process. In the formalin-sterilized systems, abatement was substantially reduced. With the

exception of the Tickfaw R., Horn Island (9-14-82), and Tchoutacabouffa R. sites, little loss of DBP from SS systems was observed, and disappearance in SW systems was virtually non-existent for all sampling sites. DBP loss in sterile systems was inconsistent, appeared resultant of site-specific factors, and, as in the active systems, was enhanced by the presence of sediment. Neither salinity, pH, biomass, nor TOC, singly or in combination, could adequately explain differences in DBP degradation either among or within sites evaluated.

Disappearance curves describing DBP abatement were of three types. In Range Point and Horn Island (9-14-82) AS, DBP degradation appeared to be substrate dependent, with the rate of degradation decreasing as DBP was depleted. In Tickfaw R., Tchoutacabouffa R., and Davis Bayou (10-19-82) AS, abatement appeared independent of substrate concentration. And, in several systems [Davis Bayou (6-9-82) AS and AW, Horn Island (9-14-82) AW, Tickfaw R. AW, Tchoutacabouffa R. AW, Fort Bayou AS and AW, and Davis Bayou (10-19-82) AW], a marked increase in degradation rate was observed during the screening period. Such increases reflect adptation of the microflora present from a population that can degrade DBP slowly, or not at all, to one capable of metabolizing the DBP molecule at a significantly higher rate. Adaptation is an increase in degradation rate substantiated by respike data in which the rate in preexposed systems is significantly higher than that observed in spiked systems not previously exposed to toxicant, as defined by Spain and Van Veld (1983). No attempt was made to differentiate among mechanisms such as gene transfer or mutation, enzyme induction, and population changes. Attempts to enumerate degraders using non-radioactive MPN techniques were not successful. Respike experiments were conducted in connection with the Davis Bayou (6-9-82) and Tchoutacabouffa R. screens (Figures 4 and 5). In the respike evaluations DBP was added carrier-free to AS and AW treatments and controls when DBP could no longer be detected in the active systems, and abatement was followed with time. In the Davis Bayou respike evaluation (Figure 4), DBP disappearance in both AS and AW respikes (C and D) was extremely rapid; all of the approximately 400 µg/ℓ respiked DBP completely degraded in 4 hours. Addition of 528 and 369 µg/ℓ DBP, respectively, to incubated AS and AW control systems not previously exposed to toxicant (E and F) resulted in lag periods similar to but somewhat shorter than those observed in the initial incubation (A and B). For the Tchoutacabouffa R. site (Figure 5), DBP degradation in AS appeared substrate independent while in AW appeared influenced by microbial adaptation after 160 hours incubation (A). Respiking the two systems with 225 µg/ℓ DBP (C) resulted in rapid degradation in AW (no DBP could be detected 10 hours subsequent to respiking). Degradation in the AS respike proceeded more slowly, roughly paralleled that prior to respiking, and indicated that adaptation did not occur. AS and AW control treatments were respiked concomitantly with their DBP-amended counterparts (B), and resulted in a decrease in DBP concentration from some 325 µg/ℓ to less than 200 µg/ℓ during 150 hours. Hence, the behavior of the respiked controls imitated that of the original prerespike AS and AW treatments, indicating that exposure to DBP is required if adaptation is to occur.

Of interest here is the confirmed microbial adaptation at Davis Bayou, an estuarine site characterized by a salinity at the time of sampling of 10 g/ℓ. Although adaptation of microbial populations in freshwater sites appears common, it has not been reported for estaurine or marine environments (Spain, Pritchard, and Bourquin, 1980; Spain and Van Veld, 1983). Although not conformed by respike data, adaptation appears to have occurred in the Horn Island (9-14-82, 27 g/ℓ salinity) and Davis Bayou (10-19-82, 21 g/ℓ salinity active water systems).

Data characterized by variable disappearance curves are difficult to describe by rate constants and resultant half-life values. K_1 values were determined as previously described, along with coefficients of determination (r^2) which are generally accepted as a measure of how well data are explained by a particular diagnostic approach, in this case, linear regression. Coefficient of determination values for the nine DBP screens are listed in Table 3. We assume that r^2 values in excess of 0.800 indicate that the data are adequately explained by regression analysis and that resultant rate constants and half-life values are valid. In AS treatments, 66.7 percent of the r^2 values generated were in excess of 0.800 (Table 3). Figure 3 indicates that the degradation curves for these treatments appeared to follow zero- or first-order kinetics and did not indicate microbial adaptation. Of the three AS treatments reflecting r^2 values less than 0.800, two [Davis Bayou (6-9-82) and Fort Bayou] were characterized by degradation curves which indicated microbial adaptation. Similarly, in AW treatments two systems reflected r^2 values greater than 0.800. DBP disappearances from these treatments [Range Point and Davis Bayou (6-1-82)] did not appear to involve adaptation, while the remaining seven AW treatments whose r^2 values were below 0.800 did. Degradation curves which indicated adaptation did not produce r^2 values greater than 0.800, indicating that DBP abatement through microbial adaptation cannot be adequately described by linear regression analysis and that valid K_1 and $t_{\frac{1}{2}}$ (and, hence K_1 ratio) values cannot be generated.

In SS treatments, three sites [Horn Island (9-14-82), Tchoutacabouffa R., and Tickfaw R.] produced r^2 values greater than 0.800. In these three sites, at least 50 percent of added DBP was lost during the screening evaluation. In the six remaining SS treatments and in all nine SW treatments, DBP abatement was substantially reduced and all r^2 values were less than 0.800. In sterile systems, then, as the slope of the degradation curve approached zero, r^2 values became increasingly diminished and valid half-life values could not be estimated.

Since it is generally preferable, for regulatory and comparative purposes, to numerically describe the disappearance of xenobiotics, we have visually determined directly from the disappearance curve for each treatment the actual time to one-half the starting DBP concentration ($ATSC_{\frac{1}{2}}$) for each geographical site. These values are indicated in Table 4. In AS treatments $ATSC_{\frac{1}{2}}$ ranged from 1.0 to 4.8 days, indicating rapid disappearance of DBP from microbially active sediment and water. In AW treatments the range was from 1.7 to 13.0 days, indicating that while

DBP abatement remained relatively rapid in active water-only systems, removal of sediment-associated microorganisms did result in a substantial decrease in DBP abatement. In the SS systems, only three of the nine evaluations produced calcuable $ATSC_{\frac{1}{2}}$ values (Tickfaw R. SS came quite close after 12 days) and in SW treatments, no $ATSC_{\frac{1}{2}}$ values could be produced. Data resultant from the sterile treatments indicate that DBP degradation under the conditions of these screens was strongly microbiologically oriented. The $t_{\frac{1}{2}}$ values included in Table 4 generally parallel the $ATSC_{\frac{1}{2}}$s, indicating that for disappearance curves following zero- or first-order kinetics, $ATSC_{\frac{1}{2}}$ reasonably-well predicts $t_{\frac{1}{2}}$. This may infer that a similar relationship exists for adaptive degradation and that $ATSC_{\frac{1}{2}}$ adequately describes DBP disappearance under these conditions.

Toxicity Testing

With respect to the toxicity testing portion of the Fate/Toxicity Screen, 96-hour minimum effective concentrations (MECs) have been determined for the species indicated in Table 5. As stated previously, the mysid shrimp and water flea served as primary test species, but occasional additional tests with the sheepshead minnow, *Cyprinodon variegatus*, (saltwater) and the fathead minnow, *Pimphales promelas*, (freshwater) were included when these animals were available. Methyl parathion is toxic to mysids and daphnids at low µg/ℓ (ppb) levels while toxicity to the fathead minnow is in the 200 ppb range. Dimilin, an inhibitor of chitin deposition in insects, proved quite toxic to the crustaceans as expected and was less toxic to the two fish. DBP and hoelon reflected high MEC values, and toxicity tests were not run concomitant with these screening evaluations. For trifluralin, PCNB, and bravo, the fate screen active sediment supernatant was assayed without dilution in attempts to detect toxic degradation products. For those materials toxic in the 200 µg/ℓ or less range (methyl parathion, dimilin, dursban, bolero, phorate, and endosulfan), the active sediment supernatant was diluted as required to produce at least one concentration which resulted in partial mortality and one concentration that resulted in total mortality.

In the trifluralin, PCNB, and bravo screens, mysid shrimp assays employing undiluted active sediment supernatant at no time indicated the presence of toxicity (which, if present, would be attributable to a toxic degradation product). For methyl parathion, dimilin, dursban, bolero, phorate, and endosulfan, toxicity associated with the active sediment supernatant disappeared in direct proportion to abatement of parent compound, indicating that toxic degradation products were not produced during the degradative process or, if produced, were degraded further before accumulation to a toxic level.

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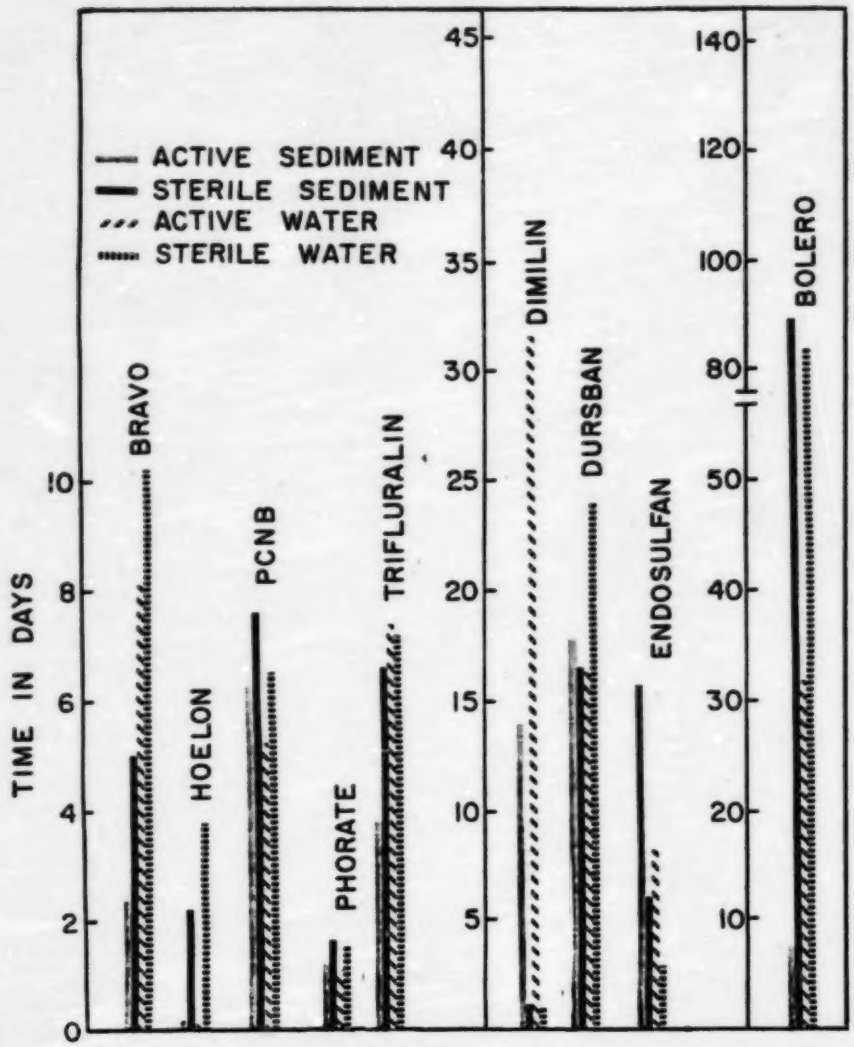


Figure 1. Half-Life Values for Test Compounds.

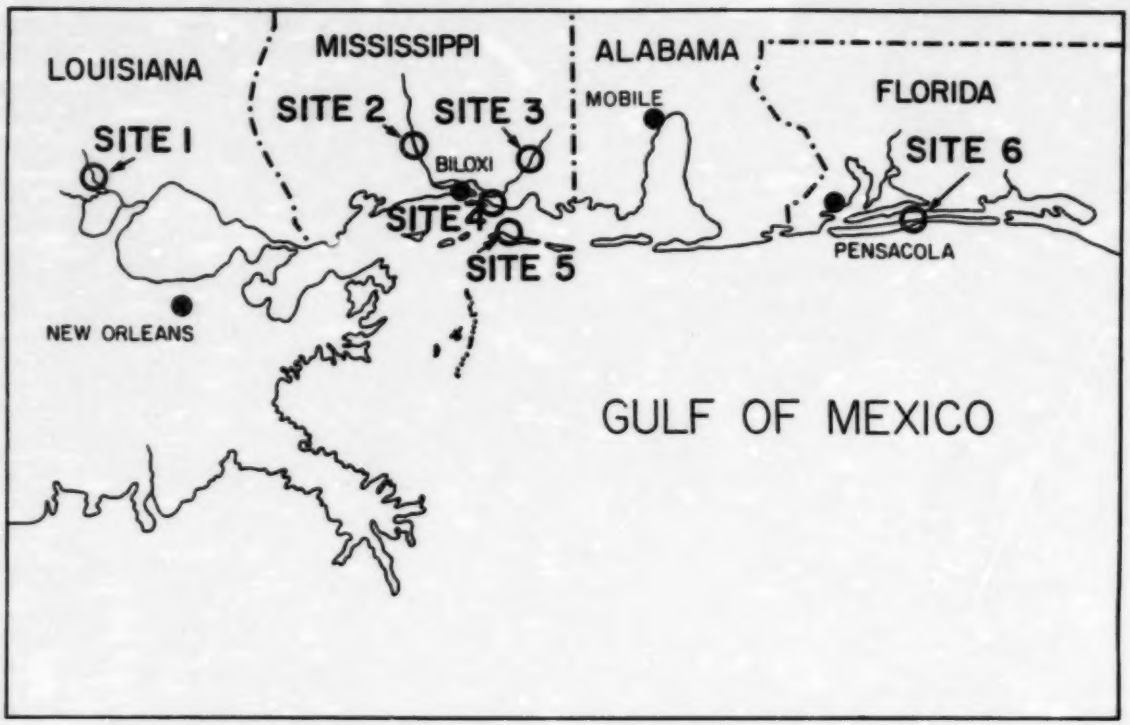


Figure 2. Sediment and Water Collection Sites.

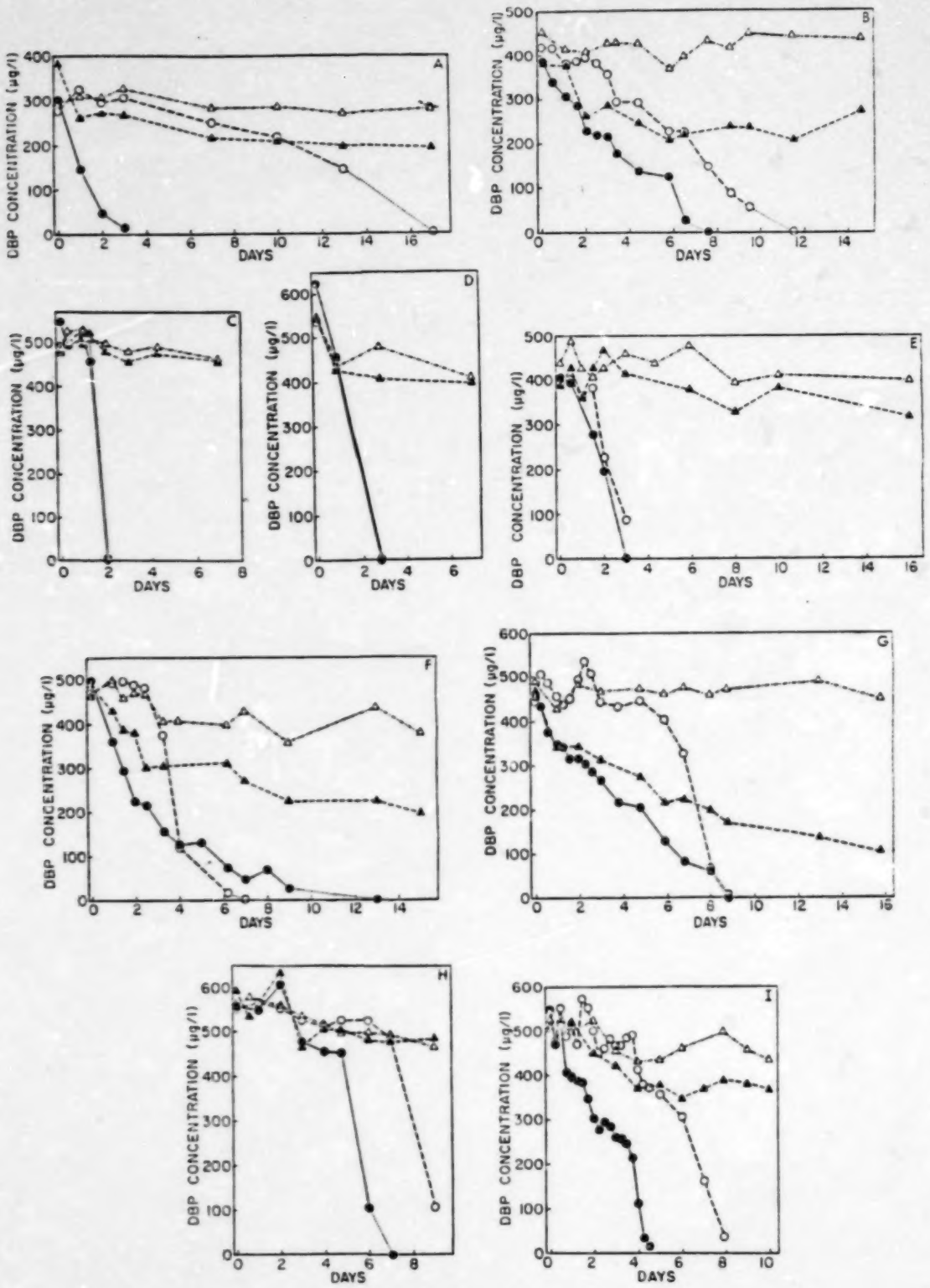


Figure 3. DBP disappearance during nine screening evaluations from six geographic sites. A, Range Point 4-82; B, Tickfaw R. 12-7-82; C, Davis Bayou 6-9-82; D, Davis Bayou 6-1-82; E, Horn Island 6-22-82; F, Horn Island 9-14-82; G, Tchoutacabouffa R. 11-2-82; H, Fort Bayou 8-31-82; I, Davis Bayou 10-19-82. Active sediment (●—●), active water (○—○), sterile sediment (▲—▲), sterile water (△—△).

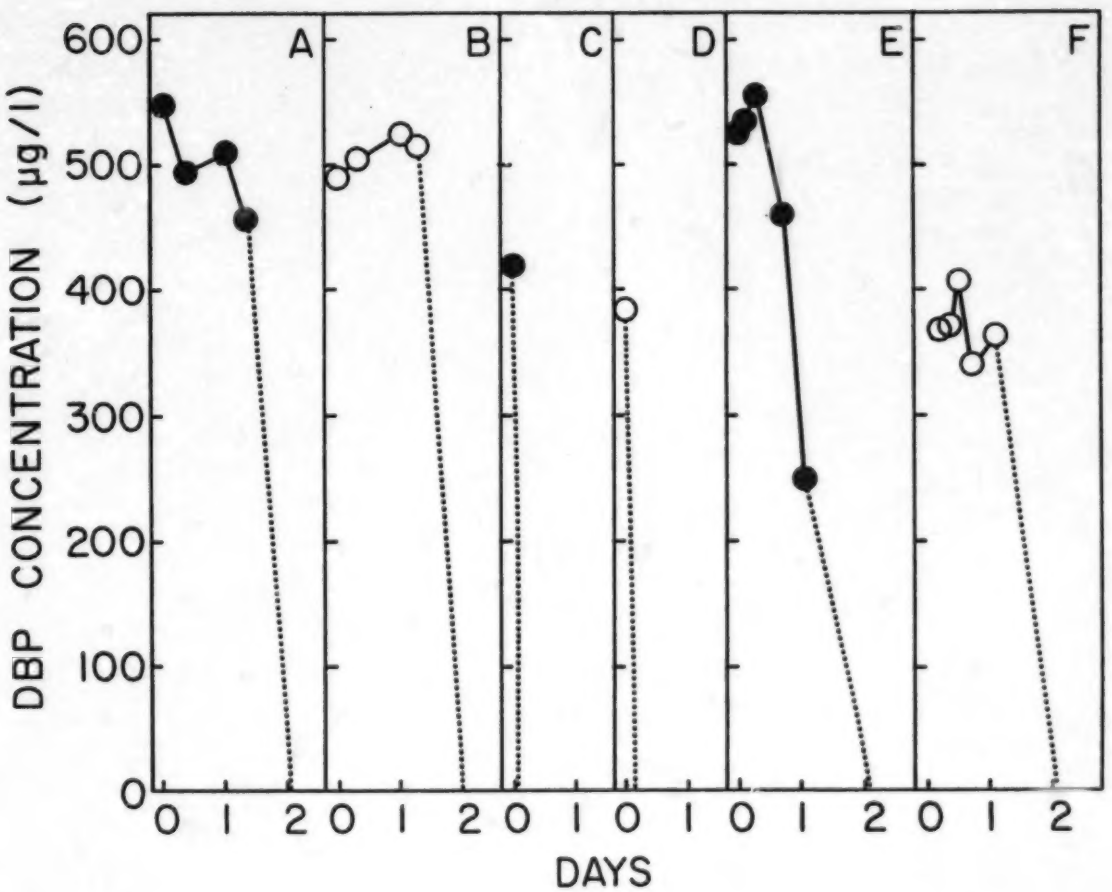


Figure 4. DBP Disappearance from Davis Bayou (6-9-82) Sediment/Water Systems. A, active sediment; B, active water; C, AS respike; D, AW respike; E, AS control spike; F, AW control spike.

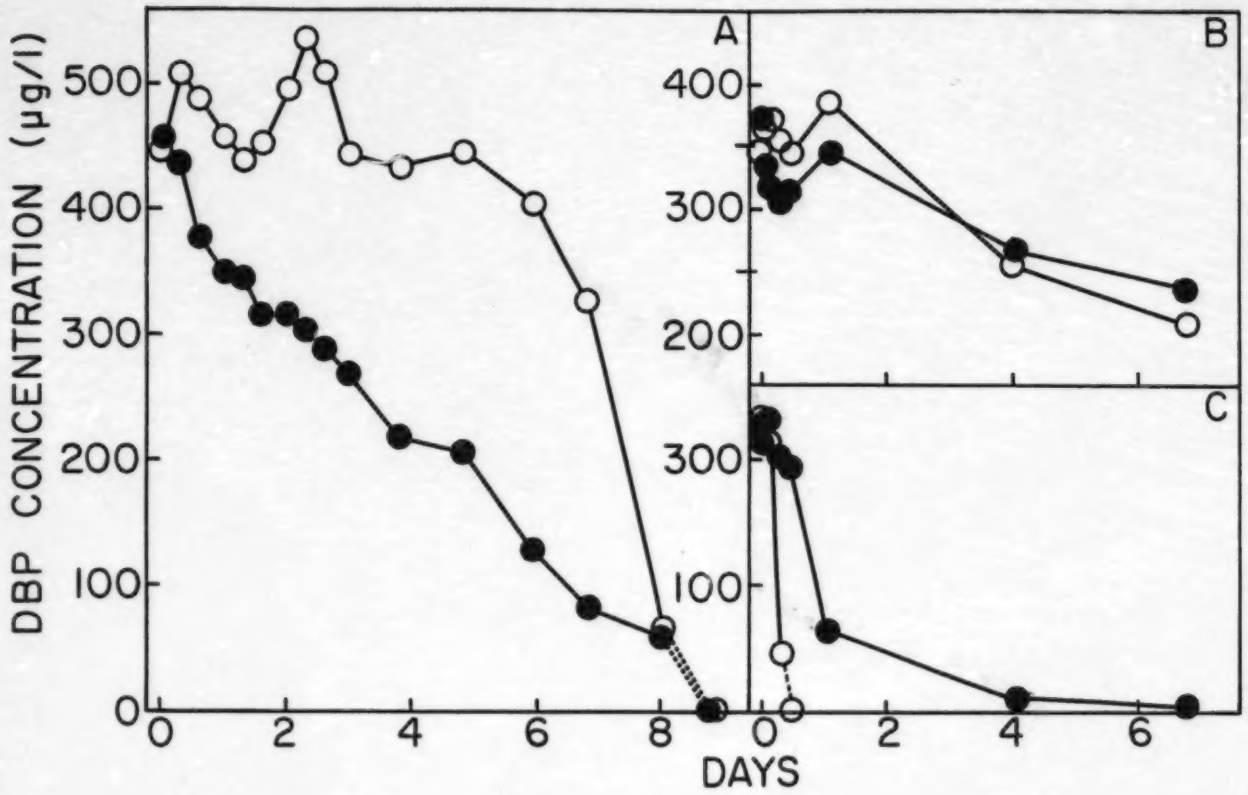


Figure 5. DBP Disappearance from Tchoutacabouffa River Sediment/Water Systems. A, active sediment (●—●) and active water (○—○); B, spiked AS (●—●) and AW (○—○) controls; C, AS (●—●) and AW (○—○) respikes.

Table 1. Nomenclature, Action, and Structure of Test Materials.

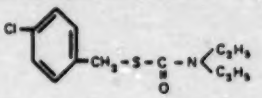
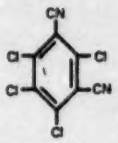
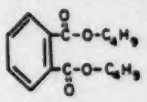
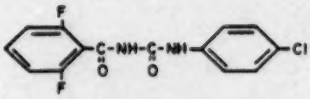
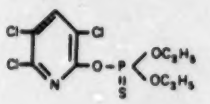
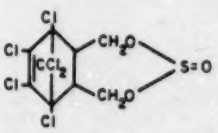
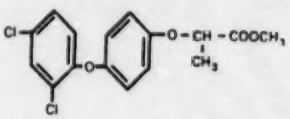
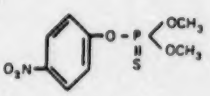
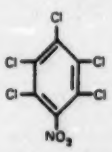
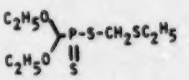
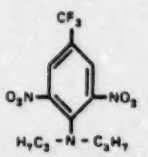
Common Name(s)	Chemical Name	Action	Structure
Bolero (Thiobencarb)	S-(4-chlorophenyl) methyl diethylcarbamothioate	Herbicide	
Bravo (Chlorothalonil)	Tetrachloroisophthalonitrile	Fungicide	
Dibutylphthalate (DBP)	n-Butyl Phthalate or Phthalic Acid Dibutyl Ester	Plasticizer, Insect Repellent	
Dimilin (Diflubenzuron)	1-(4-chlorophenyl) 3-(2,6-difluorobenzoyl) urea	Insecticide (Growth Regulator)	
Dursban (Chloropyrifos)	O,O-Diethyl O-(3,5,6-trichloro-2-pyridyl)-phosphorothioate	Insecticide	
Endosulfan	6,7,8,9,10,10-Hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzo (e)-dioxathiepin-3-oxide	Insecticide, Acaricide	
Hoelon (Diclofop methyl)	Methyl 2-[4-(2',4'-dichlorophenoxy)-phenoxy] propanoate	Herbicide	
Methyl Parathion	O,O-Dimethyl-O,p-nitrophenyl phosphorothioate	Insecticide	
PCNB	Pentachloronitobenzene	Fungicide	
Phorate (Timet)	O,O-Diethyl S-[(ethylthio)methyl] phosphorodithioate	Insecticide	
Trifluralin (Treflan)	a,a,a,-Trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine	Herbicide	

Table 2. Test Chemical/Methyl Parathion K_1 Ratios.

	Active		Sterile	
Test Chemical, date	Sediment	Water	Sediment	Water
Bolero, March 1980	1.2	0.6	0.6	0.7
Bolero, August 1981[1]	0.3	nd[2]	0.2	nd
Bravo, July 1981	12.6	6.0	13.1	8.8
DBP, June 1, 1982[1]	6.3	4.0	0.8	0.7
DBP, June 9, 1982[1]	1.4	1.6	0.6	0.5
DBP, June 22, 1982[1]	4.5	8.0	0.4	0.1
DBP, August 1982[1]	1.3	0.2	3.1	2.3
DBP, September 1982[1]	6.2	15.9	2.0	0.1
Dimilin, April 2, 1982[1]	2.2	nd	3.0	nd
Dimilin, April 16, 1982[1]	2.4	nd	3.5	nd
Dimilin, April 29, 1982[1]	0.9	nd	27.3	nd
Dursban, March 1980	0.5	1.1	3.4	2.4
Dursban, May 1981[1]	0.6	1.3	1.1	1.7
Endosulfan, October 1981[1]	1.5	6.0	14.7	39.3
Endosulfan, November 1981[1]	1.6	9.1	7.0	9.2
Hoelon, August 1980	60.9	66.2	21.4	2.0
Hoelon, October 1980[1]	149.8	207.3	17.0	9.8
PCNB, July 1981	4.7	9.4	8.6	13.9
Phorate, August 1980	16.6	38.0	25.0	15.8
Trifluralin, August 1981[1]	4.2	4.5	10.2	10.2

[1]Mean of duplicate evaluations.

[2]Not done.

Table 3. Coefficient of Determination (r^2) Values for Active and Sterile Sediment and Water Treatments in Nine Dibutylphthalate Fate Screen Evaluations.

		r^2			
Collection Site	Date	AS	AW	SS	SW
Range Point	4-82	.980	.830	.714	.538
Davis Bayou	6-1-82	1.000	.936	.538	.515
Davis Bayou	6-9-82	.585	.524	.423	.316
Horn Island	6-22-82	.916	.597	.378	.142
Fort Bayou	8-31-82	.600	.480	.438	.714
Horn Island	9-14-82	.983	.715	.880	.360
Davis Bayou	10-19-82	.642	.552	.637	.316
Tchoutacabouffa R.	11-2-82	.959	.469	.970	.003
Tickfaw R.	12-7-82	.863	.550	.806	.529

Table 4. Actual Time to One-Half Starting Concentration ($ATSC_{\frac{1}{2}}$) Values for Active and Sterile Sediment and Water Treatments in Nine Dibutylphthalate Fate Screen Evaluations.

		$ATSC_{\frac{1}{2}}$ in Days			
Collection Site	Date	AS	AW	SS	SW
Range Point	4-82	1.0(0.6)[1]	13.1(13.5)	17.0(23.0)	nc
Davis Bayou	6-1-82	1.5(1.8)	1.7(3.4)	nc[2]	nc
Davis Bayou	6-9-82	1.6	1.7	nc	nc
Horn Island	6-22-82	2.0(2.0)	2.4	nc	nc
Fort Bayou	8-31-82	4.8	7.0	nc	nc
Horn Island	9-14-82	1.9(2.2)	5.2	8.0(12.7)	nc
Davis Bayou	10-19-82	2.6	6.2	nc	nc
Tchoutacabouffa R.	11-2-82	3.6(2.9)	7.3	5.6(7.9)	nc
Tickfaw R.	12-7-82	3.6(2.3)	6.8	nc(12.8)	nc

[1]Parenthetical expressions are half-life values in days for those systems producing r^2 values greater than 0.800. Half-life for Range Point SS is included for comparative purposes even though $r^2 = 0.714$.

[2]Not calcuable.

Table 5. Toxicity of Test Chemicals to Selected Species.

Compound	Species	96-hr MEC (µg/ℓ)[1]
Bolero	*Mysidopsis*	9.3
Bravo	*Mysidopsis*	>162
Dibutylphthalate	*Mysidopsis*	2696
Dibutylphthalate	*Daphnia*	1887
Dimilin	*Mysidopsis*	3.3
Dimilin	*Daphnia*	0.2
Dimilin	*Pimphales*	22
Dimilin	*Cyprinodon*	67
Dursban	*Mysidopsis*	0.05
Endosulfan	*Mysidopsis*	4.5
Hoelon	*Mysidopsis*	961
Hoelon	*Cyprinodon*	3000
Methyl Parathion	*Mysidopsis*	0.3-1.2
Methyl Parathion	*Daphnia*	3.8-6.3
Methyl Parathion	*Pimphales*	212
PCNB	*Mysidopsis*	>140
Phorate	*Mysidopsis*	1.1
Trifluralin	*Mysidopsis*	>74

[1]Concentration required to produce mortality significantly different from control.

Table A-1. Regression equations, coefficients of determination, first-order rate constants, and half-life values for fate screen compounds.

Treatment	Regression Equation	r^2	K_1 (hr^{-1})	$t_{\frac{1}{2}}$ (days)
Bolero (March, 1980)				
Active Sediment	y = 2.34 - 0.00186x	0.621	0.00428	6.7
Sterile Sediment	y = 2.32 - 0.00014x	0.270	0.00032	89.6
Active Water	y = 2.21 - 0.00039x	0.781	0.00090	32.1
Sterile Water	y = 2.34 - 0.00015x	0.503	0.00035	83.6
Bolero (August, 1981; Rep 1)				
Active Sediment	y = 2.24 - 0.00030x	0.941	0.00068	42.4
Sterile Sediment	y = 2.23 - 0.00002x	0.088	0.00006	518.8
Bolero (August, 1981; Rep 2)				
Active Sediment	y = 2.25 - 0.00030x	0.966	0.00069	42.0
Sterile Sediment	y = 2.24 - 0.00003x	0.230	0.00007	417.9
Bravo (July, 1981)				
Active Sediment	y = 2.14 - 0.00531x	0.910	0.01224	2.4
Sterile Sediment	y = 2.15 - 0.00249x	0.902	0.00574	5.0
Active Water	y = 2.28 - 0.00154x	0.908	0.00355	8.1
Sterile Water	y = 2.33 - 0.00123x	0.826	0.00283	10.2
Dibutylphthalate (June 1, 1982, Davis Bayou; Rep 1)				
Active Sediment	y = 2.80 - 0.00713x	1.000	0.01644	1.8
Sterile Sediment	y = 2.69 - 0.00064x	0.496	0.00149	19.4
Active Water	y = 2.74 - 0.00395x	0.998	0.00910	3.2
Sterile Water	y = 2.71 - 0.00055x	0.578	0.00127	22.7
Dibutylphthalate (June 1, 1982, Davis Bayou; Rep 2)				
Active Sediment	y = 2.79 - 0.00654x	1.000	0.01508	1.9
Sterile Sediment	y = 2.68 - 0.00062x	0.587	0.00144	20.0
Active Water	y = 2.72 - 0.00346x	0.998	0.00799	3.6
Sterile Water	y = 2.70 - 0.00053x	0.452	0.00123	23.4
Dibutylphthalate (June 9, 1982, Davis Bayou; Rep 1)				
Active Sediment	y = 2.74 - 0.00165x	0.806	0.00382	7.6
Sterile Sediment	y = 2.69 - 0.00019x	0.391	0.00045	63.8
Active Water	y = 2.70 - 0.00105x	0.343	0.00244	11.8
Sterile Water	y = 2.71 - 0.00014x	0.135	0.00034	84.4
Dibutylphthalate (June 9, 1982, Davis Bayou; Rep 2)				
Active Sediment	y = 2.71 - 0.00090x	0.232	0.00208	13.9
Sterile Sediment	y = 2.70 - 0.00021x	0.456	0.00048	59.6
Active Water	y = 2.69 - 0.00056x	0.085	0.00130	22.3
Sterile Water	y = 2.71 - 0.00032x	0.496	0.00076	38.2

(Continued)

Table A-1. (Continued)

Treatment	Regression Equation	r^2	K_1 (hr^{-1})	$t_{\frac{1}{2}}$ (days)
----------Dibutylphthalate (June 22, 1982, Horn Island; Rep 1)----------				
Active Sediment	y = 2.65 - 0.00663x	0.960	0.01528	1.9
Sterile Sediment	y = 2.63 - 0.00028x	0.293	0.00066	43.5
Active Water	y = 2.65 - 0.00247x	0.331	0.00571	5.1
Sterile Water	y = 2.64 - 0.00013x	0.169	0.00032	89.7
----------Dibutylphthalate (June 22, 1982, Horn Island; Rep 2)----------				
Active Sediment	y = 2.61 - 0.00604x	0.873	0.01392	2.1
Sterile Sediment	y = 2.62 - 0.00030x	0.462	0.00071	40.7
Active Water	y = 2.66 - 0.00527x	0.863	0.01215	2.4
Sterile Water	y = 2.66 - 0.00011x	0.116	0.00027	108.7
----------DBP (August 31, 1982, Fort Bayou; Rep 1)----------				
Active Sediment	y = 2.99 - 0.00983x	0.666	0.02264	1.3
Sterile Sediment	y = 2.75 - 0.00046x	0.425	0.00107	27.1
Active Water	y = 2.76 - 0.00101x	0.484	0.00234	12.4
Sterile Water	y = 2.77 - 0.00054x	0.824	0.00126	23.0
----------DBP (August 31, 1982, Fort Bayou; Rep 2)----------				
Active Sediment	y = 2.88 - 0.00371x	0.533	0.00855	3.4
Sterile Sediment	y = 2.76 - 0.00040x	0.450	0.00093	31.0
Active Water	y = 2.87 - 0.00227x	0.476	0.00523	5.5
Sterile Water	y = 2.75 - 0.00032x	0.605	0.00075	38.4
----------DBP (September 14, 1982, Horn Island; Rep 1)----------				
Active Sediment	y = 2.68 - 0.00585x	0.984	0.01349	2.1
Sterile Sediment	y = 2.63 - 0.00093x	0.897	0.00219	13.2
Active Water	y = 3.10 - 0.01178x	0.748	0.02714	1.1
Sterile Water	y = 2.67 - 0.00025x	0.450	0.00059	49.1
----------DBP (September 14, 1982, Horn Island; Rep 2)----------				
Active Sediment	y = 2.64 - 0.00555x	0.982	0.01280	2.3
Sterile Sediment	y = 2.62 - 0.00103x	0.865	0.00238	12.1
Active Water	y = 2.74 - 0.00193x	0.990	0.00445	6.5
Sterile Water	y = 2.66 - 0.00025x	0.269	0.00059	49.1
----------DBP (October 19, 1982, Davis Bayou)----------				
Active Sediment	y = 2.85 - 0.00839x	0.642	0.01934	1.5
Sterile Sediment	y = 2.68 - 0.00059x	0.637	0.00137	21.1
Active Water	y = 2.83 - 0.00314x	0.552	0.00724	4.0
Sterile Water	y = 2.70 - 0.00022x	0.316	0.00053	54.9
----------DBP (November 2, 1982, Tchoutacabouffa R.)----------				
Active Sediment	y = 2.70 - 0.00439x	0.956	0.01011	2.9
Sterile Sediment	y = 2.60 - 0.00158x	0.970	0.00365	7.9
Active Water	y = 2.78 - 0.00259x	0.469	0.00597	4.8
Sterile Water	y = 2.67 - 0.00000x	0.003	0.00002	1578.8

(Continued)

Table A-1. (Continued)

Treatment	Regression Equation	r^2	K_1 (hr^{-1})	$t_{\frac{1}{2}}$ (days)
DBP (December 7, 1982, Tickfaw R.)				
Active Sediment	y = 2.63 - 0.00544x	0.780	0.01254	2.3
Sterile Sediment	y = 2.53 - 0.00098x	0.633	0.00226	12.8
Active Water	y = 2.74 - 0.00342x	0.856	0.00788	3.7
Sterile Water	y = 2.62 - 0.00003x	0.027	0.00009	322.0
Dimilin (April 2, 1982, Davis Bayou; Rep 1)				
Active Sediment	y = 1.67 - 0.00444x	0.889	0.01024	2.8
Sterile Sediment	y = 1.52 - 0.00102x	0.906	0.00237	12.2
Dimilin (April 2, 1982, Davis Bayou; Rep 2)				
Active Sediment	y = 1.68 - 0.00429x	0.846	0.00987	2.9
Sterile Sediment	y = 1.58 - 0.00087x	0.978	0.00203	14.2
Dimilin (April 16, 1982, Tchoutacabouffa R.; Rep 1)				
Active Sediment	y = 1.57 - 0.00622x	0.964	0.01434	2.0
Sterile Sediment	y - 1.58 - 0.00088x	0.920	0.00204	14.2
Dimilin (April 16, 1982, Tchoutacabouffa R.; Rep 2)				
Active Sediment	y = 1.54 - 0.00644x	0.998	0.01485	1.9
Sterile Sediment	y = 1.56 - 0.00064x	0.852	0.00150	19.2
Dimilin (April 29, 1982, Horn Island; Rep 1)				
Active Sediment	y = 1.68 - 0.00138x	0.910	0.00320	9.0
Sterile Sediment	y = 1.48 - 0.01086x	0.998	0.02501	1.1
Active Water	y = 1.68 - 0.00042x	0.778	0.00098	29.4
Sterile Water	y = 1.58 - 0.01421x	1.000	0.03273	0.8
Dimilin (April 29, 1982, Horn Island; Rep 2)				
Active Sediment	y = 1.61 - 0.00065x	0.755	0.00151	19.2
Sterile Sediment	y = 1.49 - 0.01049x	0.998	0.02417	1.2
Active Water	y = 1.66 - 0.00037x	0.677	0.00086	33.6
Sterile Water	y = 1.51 - 0.01060x	1.000	0.02443	1.2
Dursban (March, 1980)				
Active Sediment	y = 2.16 - 0.00071x	0.850	0.00164	17.7
Sterile Sediment	y = 2.10 - 0.00076x	0.857	0.00175	16.5
Active Water	y = 2.34 - 0.00077x	0.939	0.00177	16.3
Sterile Water	y = 2.12 - 0.00052x	0.876	0.00120	24.1
Dursban (May, 1981; Rep 1)				
Active Sediment	y = 2.23 - 0.00048x	0.889	0.00111	26.0
Sterile Sediment	y = 2.18 - 0.00027x	0.939	0.00062	46.3
Active Water	y = 2.24 - 0.00051x	0.990	0.00118	24.5
Sterile Water	y = 2.22 - 0.00035x	0.941	0.00082	35.0

(Continued)

Table A-1. (Continued)

Treatment	Regression Equation	r^2	K_1 (hr^{-1})	$t_{\frac{1}{2}}$ (days)
	Dursban (May, 1981; Rep 2)			
Active Sediment	y = 2.22 - 0.00044x	0.945	0.00102	28.4
Sterile Sediment	y = 2.21 - 0.00039x	0.956	0.00091	31.8
Active Water	y = 2.22 - 0.00030x	0.953	0.00070	41.0
Sterile Water	y = 2.24 - 0.00056x	0.994	0.00130	22.1
	Dursban (May, 1981; Rep 3)			
Active Sediment	y = 2.19 - 0.00049x	0.976	0.00113	25.5
Active Water	y = 2.22 - 0.00052x	0.972	0.00121	23.4
	Dursban (May, 1981; Rep 4)			
Active Sediment	y = 2.20 - 0.00061x	0.956	0.00141	20.4
Active Water	y = 2.22 - 0.00070x	0.968	0.00163	17.7
	Endosulfan (October, 1981; Rep 1)			
Active Sediment	y = 2.27 - 0.00072x	0.980	0.00167	17.3
Sterile Sediment	y = 2.30 - 0.00185x	0.996	0.00426	6.8
Active Water	y = 2.27 - 0.00162x	0.992	0.00374	7.7
Sterile Water	y = 2.48 - 0.00564x	0.949	0.01300	2.2
	Endosulfan (October, 1981; Rep 2)			
Active Sediment	y = 2.30 - 0.00089x	0.974	0.00207	14.0
Sterile Sediment	y = 2.36 - 0.00236x	0.986	0.00545	5.3
Active Water	y = 2.26 - 0.00145x	0.980	0.00335	8.6
Sterile Water	y = 2.41 - 0.00375x	0.980	0.00866	3.3
	Endosulfan (November, 1981; Rep 1)			
Active Sediment	y = 2.29 - 0.00071x	0.988	0.00165	17.5
Sterile Sediment[1]	y = 2.30 - 0.00119x	0.980	0.00275	10.5
Active Water	y = 2.34 - 0.00212x	0.956	0.00490	5.9
Sterile Water[1]	y = 2.44 - 0.00386x	0.859	0.00890	3.2
	Endosulfan (November, 1981; Rep 2)			
Active Sediment	y = 2.28 - 0.00128x	0.947	0.00296	9.8
Sterile Sediment[1]	y = 2.29 - 0.00120x	0.990	0.00278	10.4
Active Water	y = 2.33 - 0.00193x	0.943	0.00445	6.5
Sterile Water[1]	y = 2.34 - 0.00220x	0.976	0.00509	5.7
	Hoelon (August, 1980)			
Active Sediment	y = 2.36 - 0.03835x	0.980	0.08832	0.33
Sterile Sediment	y = 2.42 - 0.00687x	0.757	0.01582	1.8
Active Water	y = 2.52 - 0.01982x	0.988	0.04565	0.63
Sterile Water	y = 2.45 - 0.00101x	0.225	0.00232	12.4

(Continued)

Table A-1. (Continued)

Treatment	Regression Equation	r^2	K_1 (hr^{-1})	$t_{\frac{1}{2}}$ (days)
	Hoelon (October, 1980; Rep 1)			
Active Sediment	y = 2.48 - 0.23164x	0.851	0.53347	0.04
Sterile Sediment	y = 2.10 - 0.00602x	0.846	0.01385	2.1
Active Water	y = 2.28 - 0.08342x	0.922	0.19212	0.17
Sterile Water	y = 2.11 - 0.00313x	0.882	0.00721	4.0
	Hoelon (October, 1980; Rep 2)			
Active Sediment	y = 2.29 - 0.21494x	0.887	0.49501	0.04
Sterile Sediment	y = 2.10 - 0.00583x	0.859	0.01343	2.2
Active Water	y = 2.25 - 0.08431x	0.943	0.19417	0.17
Sterile Water	y = 2.12 - 0.00340x	0.773	0.00783	3.7
	Pentachloronitrobenzene (July, 1981)			
Active Sediment	y = 2.09 - 0.00198x	0.992	0.00456	6.3
Sterile Sediment	y = 2.12 - 0.00165x	0.986	0.00380	7.6
Active Water	y = 2.17 - 0.00240x	0.992	0.00553	5.2
Sterile Water	y = 2.17 - 0.00193x	0.998	0.00444	6.5
	Phorate (August, 1980)			
Active Sediment	y = 2.38 - 0.01047x	0.998	0.02411	1.2
Sterile Sediment	y = 2.36 - 0.00802x	0.986	0.01847	1.6
Active Water	y = 2.41 - 0.01138x	0.996	0.02620	1.1
Sterile Water	y = 2.37 - 0.00803x	0.998	0.01849	1.5
	Trifluralin (August, 1981; Rep 1)			
Active Sediment	y = 2.39 - 0.00270x	0.958	0.00622	4.6
Sterile Sediment	y = 2.31 - 0.00207x	0.990	0.00477	6.1
Active Water	y = 2.28 - 0.00190x	0.982	0.00438	6.6
Sterile Water	y = 2.34 - 0.00130x	0.951	0.00299	9.6
	Trifluralin (August, 1981; Rep 2)			
Active Sediment	y = 2.39 - 0.00422x	0.901	0.00972	3.0
Sterile Sediment	y = 2.32 - 0.00178x	0.978	0.00410	7.0
Active Water	y = 2.27 - 0.00152x	0.962	0.00350	8.2
Sterile Water	y = 2.45 - 0.00260x	0.958	0.00599	4.8

[1]Systems sterilized with $HgCl_2$.

Table A-2. Regression equations, coefficients of determination, first-order rate constants, and half-life values for methyl parathion. Compounds in parentheses were screened simultaneously with methyl parathion.

Treatment	Regression Equation	r^2	K_1 (hr^{-1})	$t_{\frac{1}{2}}$ (days)
March, 1980 (Dursban, Bolero)				
Active Sediment	y = 2.26 - 0.00157x	0.968	0.00362	8.0
Sterile Sediment	y = 2.23 - 0.00022x	0.345	0.00051	57.0
Active Water	y = 2.30 - 0.00069x	0.576	0.00159	18.2
Sterile Water	y = 2.26 - 0.00022x	0.542	0.00051	57.0
August, 1981; Rep 1 (Trifluralin, Bolero)				
Active Sediment	y = 2.41 - 0.00096x	0.854	0.00221	13.0
Sterile Sediment	y = 2.32 - 0.00022x	0.895	0.00050	58.3
Active Water	y = 2.31 - 0.00038x	0.976	0.00087	33.0
Sterile Water	y = 2.31 - 0.00016x	0.976	0.00038	76.8
August, 1981; Rep 2 (Trifluralin, Bolero)				
Active Sediment	y = 2.37 - 0.00076x	0.986	0.00176	16.4
Sterile Sediment	y = 2.29 - 0.00016x	0.941	0.00038	76.8
Active Water	y = 2.31 - 0.00038x	0.986	0.00087	33.4
Sterile Water	y = 2.32 - 0.00021x	0.945	0.00048	59.9
July, 1981 (Bravo, PCNB)				
Active Sediment	y = 2.29 - 0.00042x	0.966	0.00097	29.9
Sterile Sediment	y = 2.28 - 0.00019x	0.893	0.00044	66.3
Active Water	y = 2.28 - 0.00026x	0.968	0.00059	48.9
Sterile Water	y = 2.27 - 0.00014x	0.943	0.00032	89.6
June 1, 1982; Rep 1 (Dibutylphthalate, Davis Bayou)				
Active Sediment	y = 2.37 - 0.00097x	0.943	0.00225	12.8
Sterile Sediment	y = 2.36 - 0.00079x	0.865	0.00183	15.8
Active Water	y = 2.40 - 0.00103x	0.904	0.00238	12.1
Sterile Water	y = 2.35 - 0.00077x	0.935	0.00179	16.2
June 1, 1982; Rep 2 (Dibutylphthalate, Davis Bayou)				
Active Sediment	y = 2.40 - 0.00123x	0.908	0.00286	10.1
Sterile Sediment	y = 2.36 - 0.00073x	0.887	0.00170	17.0
Active Water	y = 2.37 - 0.00084x	0.876	0.00194	14.9
Sterile Water	y = 2.35 - 0.00074x	0.950	0.00170	16.9
June 9, 1982; Rep 1 (Dibutylphthalate, Davis Bayou)				
Active Sediment	y = 2.41 - 0.00096x	0.882	0.00223	12.9
Sterile Sediment	y = 2.33 - 0.00035x	0.925	0.00081	35.8
Active Water	y = 2.36 - 0.00048x	0.978	0.00112	25.7
Sterile Water	y = 2.35 - 0.00059x	0.982	0.00137	21.0

(Continued)

Table A-2. (Continued)

Treatment	Regression Equation	r^2	K_1 (hr^{-1})	$t_{\frac{1}{2}}$ (days)
---------June 9, 1982; Rep 2 (Dibutylphthalate, Davis Bayou)----------				
Active Sediment	y = 2.37 - 0.00080x	0.904	0.00187	15.5
Sterile Sediment	y = 2.33 - 0.00037x	0.960	0.00087	33.2
Active Water	y = 2.36 - 0.00050x	0.956	0.00117	24.6
Sterile Water	y = 2.33 - 0.00041x	0.980	0.00096	30.2
--------June 22, 1982; Rep 1 (Dibutylphthalate, Horn Island)----------				
Active Sediment	y = 2.45 - 0.00132x	0.951	0.00306	9.4
Sterile Sediment	y = 2.37 - 0.00043x	0.953	0.00100	28.8
Active Water	y = 2.38 - 0.00048x	0.904	0.00111	26.0
Sterile Water	y = 2.36 - 0.00080x	0.949	0.00186	15.5
--------June 22, 1982; Rep 2 (Dibutylphthalate, Horn Island)----------				
Active Sediment	y = 2.50 - 0.00152x	0.941	0.00351	8.2
Sterile Sediment	y = 2.37 - 0.00046x	0.914	0.00107	27.0
Active Water	y = 2.37 - 0.00047x	0.972	0.00112	26.1
Sterile Water	y = 2.37 - 0.00081x	0.955	0.00187	15.5
--------August 31, 1982; Rep 1 (Dibutylphthalate, Fort Bayou)----------				
Active Sediment	y = 2.44 - 0.00404x	0.988	0.00932	3.1
Sterile Sediment	y = 2.35 - 0.00010x	0.183	0.00024	119.0
Active Water	y = 2.54 - 0.01103x	0.907	0.02540	1.1
Sterile Water	y = 2.36 - 0.00018x	0.949	0.00043	67.5
--------August 31, 1982; Rep 2 (Dibutylphthalate, Fort Bayou)----------				
Active Sediment	y = 2.64 - 0.01396x	0.935	0.03215	0.9
Sterile Sediment	y = 2.37 - 0.00024x	0.482	0.00056	51.9
Active Water	y = 2.63 - 0.00742x	0.551	0.01711	1.7
Sterile Water	y = 2.36 - 0.00019x	0.837	0.00044	65.0
------September 14, 1982; Rep 1 (Dibutylphthalate, Horn Island)----------				
Active Sediment	y = 2.40 - 0.00097x	0.990	0.00225	12.8
Sterile Sediment	y = 2.37 - 0.00046x	0.978	0.00107	27.1
Active Water	y = 2.39 - 0.00035x	0.992	0.00081	35.7
Sterile Water	y = 2.39 - 0.00160x	0.994	0.00369	7.8
------September 14, 1982; Rep 2 (Dibutylphthalate, Horn Island)----------				
Active Sediment	y = 2.40 - 0.00087x	0.992	0.00201	14.3
Sterile Sediment	y = 1.69 - 0.00472x	0.716	0.01087	2.7
Active Water	y = 2.39 - 0.00035x	0.978	0.00083	35.0
Sterile Water	y = 2.53 - 0.00495x	0.996	0.01141	2.5
------------April 2, 1981; Rep 1 (Dimilin, Davis Bayou)----------				
Active Sediment	y = 2.48 - 0.00631x	0.910	0.01453	2.0
Sterile Sediment	y = 2.30 - 0.00046x	1.000	0.00107	27.0

(Continued)

Table A-2. (Continued)

Treatment	Regression Equation	r^2	K_1 (hr^{-1})	$t_{\frac{1}{2}}$ (days)
----------April 2, 1982; Rep 2 (Dimilin, Davis Bayou)----------				
Active Sediment	y = 2.29 - 0.00113x	0.968	0.00261	11.0
Sterile Sediment	y = 2.25 - 0.00023x	0.757	0.00055	52.6
---------April 16, 1982; Rep 1 (Dimilin, Tchoutacabouffa R.)----------				
Active Sediment	y = 2.29 - 0.00280x	0.974	0.00646	4.5
Sterile Sediment	y = 2.25 - 0.00024x	0.587	0.00057	50.3
---------April 16, 1982; Rep 2 (Dimilin, Tchoutacabouffa R.)----------				
Active Sediment	y = 2.27 - 0.00255x	0.982	0.00589	4.9
Sterile Sediment	y = 2.26 - 0.00018x	0.986	0.00043	66.9
----------April 29, 1982; Rep 1 (Dimilin, Horn Island)----------				
Active Sediment	y = 2.26 - 0.00110x	0.865	0.00255	11.3
Sterile Sediment	y = 2.27 - 0.00037x	0.945	0.00086	33.6
----------April 29, 1982; Rep 2 (Dimilin, Horn Island)----------				
Active Sediment	y = 2.26 - 0.00115x	0.986	0.00266	10.8
Sterile Sediment	y = 2.29 - 0.00041x	0.904	0.00095	30.4
----------May, 1981; Rep 1 (Dursban)----------				
Active Sediment	y = 2.35 - 0.00089	0.978	0.00206	14.0
Sterile Sediment	y = 2.32 - 0.00030x	0.823	0.00070	41.5
Active Water	y = 2.31 - 0.00033x	0.902	0.00078	36.9
Sterile Water	y = 2.32 - 0.00026x	0.901	0.00061	47.0
----------May, 1981; Rep 2 (Dursban)----------				
Active Sediment	y = 2.34 - 0.00087x	0.978	0.00200	14.4
Sterile Sediment	y = 2.31 - 0.00031x	0.904	0.00073	39.5
Active Water	y = 2.32 - 0.00040x	0.939	0.00094	30.8
Sterile Water	y = 2.32 - 0.00028x	0.920	0.00065	44.5
----------May, 1981; Rep 3 (Dursban)----------				
Active Sediment	y = 2.34 - 0.00086x	0.939	0.00199	14.5
Active Water	y = 2.31 - 0.00042x	0.927	0.00099	29.3
----------May, 1981; Rep 4 (Dursban)----------				
Active Sediment	y = 2.37 - 0.00091x	0.937	0.00211	13.7
Active Water	y = 2.31 - 0.00042x	0.925	0.00097	29.8
----------October, 1981; Rep 1 (Endosulfan)----------				
Active Sediment	y = 2.32 - 0.00049x	0.960	0.00114	25.3
Sterile Sediment	y = 2.30 - 0.00014x	0.956	0.00033	87.8
Active Water	y = 2.33 - 0.00026x	0.958	0.00061	47.4
Sterile Water	y = 2.30 - 0.00012x	0.956	0.00028	102.5

(Continued)

Table A-2. (Continued)

Treatment	Regression Equation	r^2	K_1 (hr^{-1})	$t_{\frac{1}{2}}$ (days)
October, 1981; Rep 2 (Endosulfan)				
Active Sediment	y = 2.32 - 0.00062x	0.978	0.00143	20.1
Sterile Sediment	y = 2.30 - 0.00014x	0.976	0.00033	87.4
Active Water	y = 2.32 - 0.00024x	0.910	0.00057	51.1
Sterile Water	y = 2.30 - 0.00011x	0.968	0.00027	108.6
November, 1981; Rep 1 (Endosulfan)				
Active Sediment	y = 2.32 - 0.00063x	0.976	0.00146	19.8
Sterile Sediment	y = 2.29 - 0.00017x	0.976	0.00040	71.4
Active Water	y = 2.30 - 0.00022x	0.945	0.00052	55.0
Sterile Water	y = 2.30 - 0.00033x	0.994	0.00077	37.2
November, 1981; Rep 2 (Endosulfan)				
Active Sediment	y = 2.32 - 0.00061x	0.976	0.00142	20.4
Sterile Sediment	y = 2.29 - 0.00016x	0.885	0.00039	74.8
Active Water	y = 2.30 - 0.00022x	0.958	0.00051	56.3
Sterile Water	y = 2.31 - 0.00032x	0.914	0.00074	38.8
August, 1980 (Hoelon, Phorate)				
Active Sediment	y = 2.33 - 0.00063x	0.966	0.00145	19.9
Sterile Sediment	y = 2.31 - 0.00032x	0.968	0.00074	39.2
Active Water	y = 2.32 - 0.00030x	0.908	0.00069	41.8
Sterile Water	y = 2.34 - 0.00051x	0.834	0.00117	24.6
October, 1980; Rep 1 (Hoelon)				
Active Sediment	y = 2.39 - 0.00162x	0.960	0.00373	7.7
Sterile Sediment	y = 2.30 - 0.00034x	0.988	0.00078	36.9
Active Water	y = 2.30 - 0.00036x	0.929	0.00083	34.8
Sterile Water	y = 2.33 - 0.00034x	0.978	0.00078	36.9
October, 1980; Rep 2 (Hoelon)				
Active Sediment	y = 2.34 - 0.00137x	0.980	0.00316	9.2
Sterile Sediment	y = 2.32 - 0.00036x	0.978	0.00083	34.8
Active Water	y = 2.33 - 0.00046x	0.949	0.00106	27.3
Sterile Water	y = 2.33 - 0.00033x	0.956	0.00076	38.0